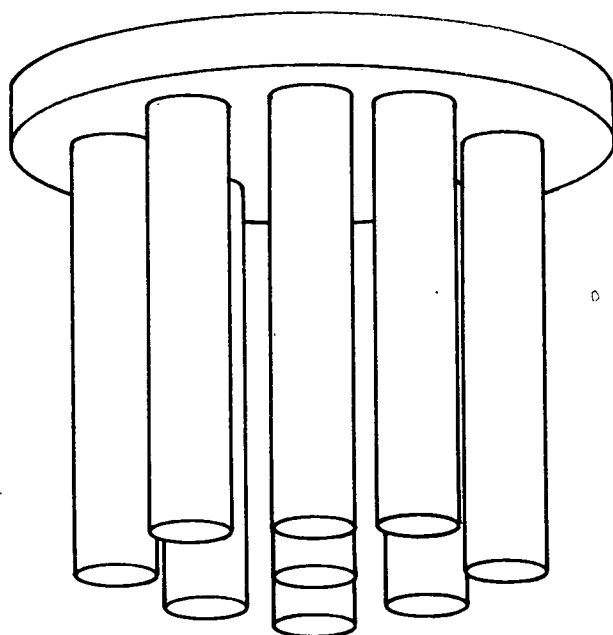


NASA TECH BRIEF



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Tube-To-Header Joint for Bimetallic Construction



Typical Header Array

Figure 1

The problem:

There has been an increasing use of bimetallic construction where a protective cladding is used over or within an inexpensive backing material, and where particular and different properties are required on alternate sides of the construction. The fabrication of bimetallic systems for corrosive fluid containment often requires brazed or welded joints. Brazing has been employed when corrosion conditions do not adversely affect the brazing alloys. Welding, which causes alloy mixing, has been used on bimetallic combinations of compatible alloys such as carbon steel and stainless steel. The particular demands of high-temperature, liquid-metal heat-transfer systems,

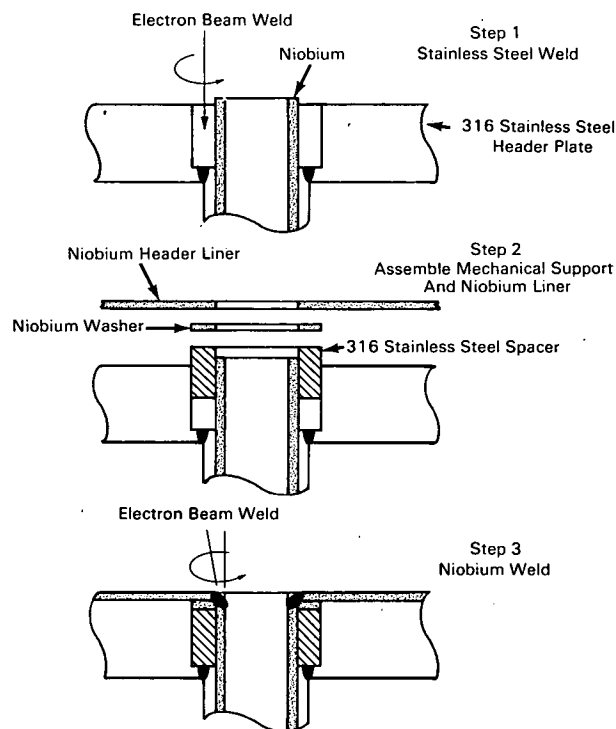


Figure 2

however, impose strict requirements on brazing systems and preclude any bimetallic alloying during welding. An added requirement is that temperatures encountered in any selected joining cycle must not cause excessive diffusion reactions at the bimetallic interface.

Bimetallic tube-to-header joints, such as shown in Figure 1, pose an additional problem. These require that all the welding be done from the top of the header as the close proximity of the tubes does not provide an accessible area for welding from the bottom.

The solution:

A joining process where the particular design advantages of bimetallic construction can be maintained

(continued overleaf)

through the tube and header interface, and where all the welding can be accomplished from the accessible side of the header assembly.

How it's done:

The header plate is made of 316 stainless steel. The tubing is 316 stainless steel internally clad with niobium (columbium). Electron beam welding is used as it provides precise control of the weld location and dimensions. Prior to welding, the circumference of the tube adjacent to the header is machined to remove the stainless steel and to slightly undercut the niobium liner. The tube hole in the header plate is bored oversize to a depth and diameter sufficient to permit making a full penetration circumferential weld between the tube and header as shown in Figure 2, Step 1. The tube is inserted into the header and welded to it. As indicated in Step 2, a 316 stainless steel spacer is then inserted in the bored-out area. Next, a niobium insert or washer is placed on top of the stainless steel spacer. A machined niobium liner is placed on the header to complete Step 2. Step 3 shows the final welding of the niobium header liner to the niobium washer.

Notes:

1. This design permits an all-welded bimetallic joint to be made from the accessible header side of the tube-to-header joint.
2. The weld joints completely seal the tube-header plate crevice and prevent crevice and stringer corrosion.
3. The localized welding process avoids the temperature cycles associated with stainless steel brazing and prevents the formation and growth of brittle diffusion zones between the bimetallic components.
4. The two-piece header design requires only circumferential butt welding in configurations which are relatively insensitive to variations in weld depth and are easily and reproducibly made.

5. The all-welded joint simplifies fabrication and increases design flexibility for high-temperature corrosive environments as compared with brazed (or brazed and welded) joints which require extensive alloy and process development to ensure adequate strength, stability, and corrosion resistance.
6. The stainless steel weld at the tube side of the header assembly is a full penetration weld, and therefore, lends itself to visual process inspection. This is important, since full penetration in readily welded materials is a good measure of weld soundness and quality.
7. Although a specific bimetallic combination is described, the joint design and welding process is applicable to a wide range of bimetallic combinations.
8. This type of weld joint can also be produced utilizing a bonded bimetallic header plate. In this case, the stainless steel insert and a thick niobium washer are inserted in the bored-out area, and the niobium washer is welded to both the header plate liner and the niobium tube liner.
9. The unique features of accessible welding are also applicable to the crevice-free welding of normal header and tube assemblies of single metal construction.
10. Inquiries concerning this development may be directed to:

Technology Utilization Officer
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21000 Brookpark Road
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Reference: B67-10464

Patent status:

No patent action is contemplated by NASA.

Source: D. R. Stoner and G. G. Lessmann
of Westinghouse Corporation
under contract to
Lewis Research Center
(LEW-10282)